

Listing of Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Cancelled)
2. (Cancelled)
3. (Cancelled)
4. (Cancelled)
5. (Cancelled)
6. (Cancelled)
7. (Cancelled)
8. (Cancelled)

9. A method for measuring electrocardiographic alternans and the respiratory frequency from a plurality of electrocardiographic (ECG) signals representative of the electric activity of a heart of a patient, the method comprising the steps of:
 - obtaining the ECG signals over a predetermined number of cardiac cycles of the patient's heart from three leads;
 - dividing each ECG signal into individual cardiac cycles, each cardiac cycle having a depolarization portion and a repolarization portion;
 - measuring the amplitude of a plurality of depolarization segments of the depolarization portion of each cardiac cycle from each of the three leads;
 - measuring the amplitude of a plurality of repolarization segments of the repolarization portion of each cardiac cycle from each of the three leads;
 - transforming the plurality of amplitude measurements taken during the depolarization portion of each cardiac cycle into eigenvariables using singular value decomposition;
 - calculating a spectral density from each of the eigenvariables; and
 - determining a respiration frequency from the maximum spectral density of the first eigenvariable from the depolarization portion of the cardiac cycle.

10. The method of claim 9 wherein the amplitude of the plurality of repolarization segments are measured from a reference baseline defined by a first base segment occurring immediately prior to the repolarization portion of the present cardiac cycle and a second base segment occurring immediately prior to the depolarization portion of the subsequent cardiac cycle.

11. The method of claim 10 wherein the amplitude of the plurality of depolarization segments are measured from a second reference baseline defined by a third base segment occurring immediately prior to the depolarization portion of the present cardiac cycle and the second base segment occurring immediately prior to the depolarization portion of the subsequent cardiac cycle.

12. The method of claim 11 wherein the amplitude of each ECG signal is measured over four depolarization segments and four repolarization segments of each cardiac cycle.

13. The method of claim 12 further comprising the steps of:

filtering the amplitude measurements taken for each of the repolarization segments to remove the low frequency portion of each measurement;

transforming the twelve amplitude measurements taken for the repolarization segments into eigenvariables by using singular value decomposition; and

calculating a spectral density from each of the eigenvariables, wherein the spectral density for each of the eigenvariables is used to locate alternans.

14. A method to optimally measure electrocardiographic alternans phenomena indicative of cardiac instability, including the steps of:

A. obtaining electrocardiographic (ECG) signals from twelve leads over a predetermined number of cardiac cycles, each cardiac cycle having a depolarization portion and a repolarization portion that may exhibit alternans;

B. reducing the twelve lead ECG signals to an orthogonal 3-dimensional eigenlead set, each of the eigenleads representing a plurality of cardiac cycles;

- C. dividing the eigenlead signals into four segments for each of the depolarization and repolarization portions;
 - D. measuring the amplitude in the four segments in each of the three eigenleads for both the depolarization and repolarization portions;
 - E. arranging the twelve amplitude measurements into twelve independent linear combinations (termed eigenvariables) by rank ordering of mean-square signal amplitudes contained in each of the eigenvariables;
 - F. separating the spectral energy in the eigenvariables due to alternans from that due to respiration by:
 - i. determining the eigenvariable with the greatest amount of respiratory energy;
 - ii. establishing a reference harmonic ratio between the energy due to respiration and the energy due to alternans in the eigenvariable with the greatest amount of respiratory energy; and
 - iii. selecting eigenvariables having significant amounts of alternans spectral energy, those eigenleads having respiratory energy-alternans energy ratios bearing a predetermined relationship to the reference harmonic ratio;
 - G. determining in the selected eigenvariables, the measured power at an alternans frequency and the mean power over a selected portion of the frequency spectrum;
 - H. determining the difference between the measured power at the alternans frequency and the mean power; and
 - I. establishing that alternans indicative of cardiac instabilities exists in the electrocardiographic signals when the measured power-mean power difference exceeds a predetermined number of standard deviations.
15. The method of claim 14 wherein the repolarization portion of each eigenlead heart beat signals is divided into segments that extend beyond the end of the visible T-wave in the electrocardiographic signal.

Applicant: DAVID W. MORTARA

16. The method of claim 14 wherein the determination of the eigenvariable having the greatest amount of respiratory energy is made on the basis of QRS phenomena.
17. The method of claim 14 wherein eigenvariables having a harmonic ratio greater than 1.5 times the reference harmonic ratio are selected as having significant amounts of alternans energy.
18. The method of claim 14 wherein step I establishes that alternans exist when the number of standard deviations exceeds three.
19. The method of claim 14 further including the step of establishing an alternans score using the eigenvariable exhibiting the greatest number of standard deviations.
20. The method of claim 14 further defined as measuring respiration frequencies.